AUSTRALIAN HISTORIC ENGINEERING PLAQUING PROGRAMME
NOMINATION FOR NATIONAL ENGINEERING LANDMARK

To:
The Institution of Engineers, Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Date: 17/6/02
From: South Australia Division
Engineering Heritage Branch

The following work is nominated for a:

National Engineering Landmark

Name of Work:
Barossa Dam, South Australia

Location:
11 Km SE Gawler, South Australia
AMG Reference E302550 N6163950
(near Williamstown)

Owner:
South Australian Water Corporation (abbreviated name SA Water)
GPO Box 1751
ADELAIDE SA 5001

Owners Agreement:
SA Water is keen to have the dam recognised by the IEAust. Formal approval to participate in the plaquing process is expected to be readily given as SAW Executive has approved participation in any IEA ceremony. SAW is going to recognise the dam with its own plaque.

Access to site:
Public access to the dam and reservoir viewing area is available.

Persons Responsible for Nomination

N Ridgway, Chairman Engineering Heritage Branch

G Tilbrook, Division Director

ENGINEERING HERITAGE – ASSESSMENT

Item Name:	Barossa Dam
Location:	Near Williamstown, SA
Local Government Area:	District Council of Barossa
Current Use:	In active use as an off stream storage
Assessed Significance:	Of National and World significance.

Statement of Significance:

(This nomination is focussed on the dam wall rather than the whole Barossa Water Works scheme)

The Barossa Dam was among the first true arch dams of concrete construction built in the world. At the time of its construction it was the largest arch dam in Australia being almost double the height and three times the shell volume of the then existing large dams. The methods employed in the concrete mix design, the automatic batch weighing of concrete ingredients and concrete quality control during construction were unique. The dam demonstrated that construction of slender concrete arch walls of large size were both feasible and cost effective and aroused interest in the engineering world including both the United States of America and the United Kingdom. The Barossa Dam became a landmark in dam construction in both Australia and the world. After 100 years of service the dam wall remains in excellent condition and is evidence of the success of a bold design and the quality of its construction.

ENGINEERING HERITAGE – ASSESSMENT

Item Name: Barossa Dam

Location: Near Williamstown, SA

Historical Notes: The conception of the Barossa Dam followed from the need for an improved water supply for the developing township of Gawler and surrounding districts.

The dam was the key component in the Barossa Water Works project [shown in appended general arrangement drawing] and was designed by the South Australian Engineer in Chief's Department under the direction of the Engineer in Chief, Mr. AB Moncrieff[1]. The decision to use the arch was made by Moncreiff on the basis of this form of construction for the dam wall resulting in the lowest capital cost[1]. Moncreiff was also confident in the use of concrete after the Department's experience in constructing the large Beetaloo Dam where concrete was successfully used. There was some opposition to Moncrieff's proposal, based on lack of evidence for the relatively new form of dam construction. Moncreiff reassured his opponents that structural problems such as cracking would be minimal in an arch if it was appropriately designed. [As has been shown to be the case].

The Engineer in Chief's Department and in turn the Hydraulic Engineer's Department carried out the construction of the dam under the superintendence of Resident Engineer, Mr. OH Rogers. It was built during 1899 – 1903 with only minimal modifications since then. These modifications have been confined to handrailing along the crest of the dam wall.

Prior to the Barossa Water Works project, major dams constructed in Australia were principally of the gravity type, which relied on the weight of the wall for stability. In the USA advances had been made in dam design during the late 1800's using concrete [then a new structural material] in the more economical form of the thin wall curved arch. An outstanding and controversial example was the Bear Valley Dam[2] near Los Angeles constructed in 1884. This dam had a wall height of 19.5 m with a thickness at the bottom of 6.7 m and a top thickness of 0.9m. In Australia, the first large dam using arch theory was constructed in masonry at Parramatta in 1856[3] with the next arch dam not being completed until 1896. During the period 1896-98 and prior to commencement of the Barossa Dam, 6 concrete arch dams had been constructed or were under construction in NSW[3]. Of these, the Moore's Creek Dam had the largest wall height at 19m. The Barossa Dam was

significantly larger than any other arch dam in Australia at that time having a wall height of 35 to 36m, a wall length of 144m and a shell volume of 14000m^3. [the cross section of the dam wall is shown in the appended drawing] It was not exceeded in height by another arch dam until the construction of the Ridgeway Dam [Tas] in1919.

Thus at the time of completion of construction the Barossa Dam was amongst the first true concrete arch dams in the world, the first arch dam in South Australia, the highest arch dam in Australia and within 1 to 2 m of being the highest dam of any type in Australia. To date some 48 large arch dams have been built in Australia since the first in 1856 with only 14 having a dam wall of greater height and shell volume than Barossa.

When the Barossa was being designed the cement and concrete industry was in its infancy. The first recorded concrete dam in Australia was built for the Geelong Water Trust in 1875[4]. By the mid 1890's concrete was being used for more significant structures and dams. The gravity type Beetaloo Dam wall in the mid north of South Australia constructed in 1890 was one such structure and at the time was the largest conventional concrete dam in the world[5]. [While of similar height and length to Barossa its shell volume was almost three times that for Barossa.] For reasons of availability and quality control, imported Portland cement was chosen over the locally produced product for the Barossa Dam. The design and testing process used to select the concrete mix[3,6] was unique to the Barossa Dam. Various concrete mix samples were tested for watertightness by subjecting cubes of concrete (600mm) to a hydrostatic pressure of 60 metres head of water. On the basis of these tests, the design mix for the dam was selected.

The automatic batching of the dry concrete ingredients in on site manufacture of the concrete ensured that the design intent in concrete mix design was carried out in practice. This rigorous control on concrete quality was an Australian first and a significant advance on previous concrete mixing practice in Australia.

The attention to concrete quality has resulted in a dam wall still in excellent condition after 100 years of service. With only one crack in the dam wall[7] [attributed to seismic activity in 1954] it has performed in a manner superior to other concrete arch dam wall of earlier construction, all of which are now exhibiting several vertical cracks[3].

The Barossa Dam extended the boundaries of dam design and construction techniques in Australia. Its design was considered to be very bold[1] in its day but has been proven in practice. Indeed the Barossa Dam was one of the thinnest and highest true arch dams in the world and attracted the international interest of the Institution of Civil Engineers, London[4] and the engineering and scientific community in the USA.[6,8]

Use of the arch form in the dam wall brought cost benefits to the community contributing to a lower total project cost[6] for the Barossa Water Works of 169147 pounds compared with the approved expenditure of 225000 pounds.

"Topping of the main wall was completed on 25 September[9]" 1902 when the last concrete was placed. Filling had already commenced with the first water being supplied from the dam on 31 December 1901. When the wall was topped the dam was approximately 85% filled with 24 m [78 feet] of water against the wall.

Superintendent Rogers in his report on the 11 March 1903[10] advised "the whole of the works of construction in connection with these works [Barossa Water Works] has now been completed." This was apart from the "clerical and plan work" he hoped to bring to an early close [and in fact by 5 July 1904].

References

1 E&WS Department Construction Branch News Letter, August 1958

2 Cole BM, *Dam Technology in Australia 1850-1999,* ANCOLD 2000, p73

3 Cole BM, *Dam Technology in Australia 1850-1999,* ANCOLD 2000, p74,75,77

4 Cole BM, *Dam Technology in Australia 1850-1999,* ANCOLD 2000, p15

5 Good RJ, *200 Years of Concrete in Australia,* Concrete Institute of Australia, 1988

6 Engineering News, a Journal of Civil, Mechanical, Mining, and Electrical Engineering, Vol LI Nº14, New York 7 April 1904

7 Historical Account of Construction and Operations, E&WS Dept, August 1985

8 Scientific American, New York, 1 April, 1905

9 OH Rogers, *Report to Hydraulic Engineer,* GRG 57/13 Docket 510/02, 25 September 1902

10 OH Rogers, *Report to Hydraulic Engineer,* GRG 57/13 Docket 496/03, 11 March

National Estate

Nomination by ANCOLD and The Institution of Engineers Australia is currently before the Australian Heritage Commission with information for the National Criteria set out below.

CRITERION A4 *Importance for association with landmark events, developments or stages in Australian history or in the history of a State, region or community.*

Barossa Dam is a concrete arch dam constructed in the period 1899 – 1903 to provide an improved water supply to the historic township of Gawler and surrounding districts, which had until that time relied on local bores of deteriorating quality for water supply. Water was harvested using a diversion weir on the nearby South Para River and conveyed through a 2260m long tunnel under gravity to the reservoir of Barossa Dam, on Yettie Creek. A pipeline from the reservoir then conveyed water under gravity to Gawler.

The future of the important regional town of Gawler could have been under threat had not this scheme been instigated. The dam is a salutary reminder that water supply and settlement are closely interrelated in Australian history – that demography cannot be explained without reference to dam construction.

CRITERION B2 *Importance in demonstrating a distinctive way of life, land use, function, or design no longer practised, in danger of being lost, or of exceptional interest.*

This dam was the first arch built dam in South Australia and the highest in Australia at the time. It is the only dam of this particular type in the state. The design method is no longer practised for large dams, as the more complex, double-curvature arch design (with upstream and downstream faces curved both vertically and horizontally) currently used is much more efficient in the use of concrete and construction is thus more economical.

CRITERION D2 *Importance in demonstrating the principal characteristics of classes of human activities in the Australian environment (including way of life, custom, process, land-use, function, design or technique).*

The significance of Barossa Dam is to be found not in its function but in its form. Besides being the first arch dam is south Australia, it was the highest in Australia at the time of construction. It was amongst the first of the true concrete arch dams to be built in the world, relying solely on arch action to resist water loads, and was considered to be a very bold design in its day, particularly as little was then known of the permanent capabilities of concrete structures of this form. Up until that time the heavy concrete gravity dams had dominated dam design (mostly based on UK practice) and the arch design caused quite a stir and attracted much criticism amongst the engineering profession. Barossa Dam provided a clear demonstration of the success of this type of construction on a large scale. Substitution of the arch for a gravity design saved 24% on the original estimate for a gravity dam.

CRITERION E1 *Importance for a community for aesthetic characteristics held in high esteem or otherwise valued by the community.*

The dam site is located in a steep, wooded valley and has been developed over the years. The sweeping curve of the dam against the water and the surrounding wooded hills provide a picturesque

setting for the attractive picnic facilities established near the eastern abutment. The dam has become a popular stop for locals and visitors alike. A unique feature of the dam is the unusual acoustic phenomenon created by the shape and location of the dam. If two people located, one on each special landing provided at each abutment just below the crest of the dam and against the downstream face, it is possible for both to converse in low whispers, even though they are over 100 metres apart. This has led to the dam being given the name ‘The Whispering Wall’.

CRITERION F1 *Importance for its technical, creative, design or artistic excellence innovation or achievement.*

The decision to build an arch dam was made by Mr A B Moncrieff, the Engineer-in Chief, based on the economy of this form of construction. Mr Moncrieff visited New South Wales to inspect two arch dams that had been built there. An article on the dam written by Mr Moncrieff appeared in the Engineering News in 1904. From information shown on the original drawings it would appear that there was liaison with NSW engineers who were also building arch dams in that state during this period.
There were two other features which were unique for this period of arch dam construction in Australia.

(1) For the first time in Australia, the concrete was batched using automatic machine
(2) The concrete mix was designed then tested for watertightness by subjecting cubes of concrete (600mm) to a hydrostatic pressure of 60 metres head of water.

The dam was of an innovative design in that it was constructed entirely of concrete (previous dams were of mortared masonry and rubble construction) and owing to the curved profile was extremely economical of material compared to dams which relied on their mass for stability.

The design principle was simple in that it was the straight adoption of the well known cylinder formula which relates required wall thickness (T) to water pressure (P), radius of the arch (R) and allowable compressive stress in the wall (S) as follows: -

$$T=P \times R / S$$

As water pressure varies linearly with depth so does the thickness of the wall (except near the top of the wall where practical considerations dictated a minimum thickness of 1.37metres).

A concrete scale model of the dam is located near the dam and was built prior to construction, but its purpose remains unknown.

The dam was constructed by the then Engineer in Chief’s Department under the supervision of Resident Engineer, Mr O H

Rogers. A complete and detailed description of the dam design and construction if presented by Shannon. An eminent South Australian, Professor R W Chapman of Adelaide University, was also associated with the dam but the nature of his contribution is not known.

Some 100 years after completion the dam continues to provide a strategic storage for the water supply to the northern areas of greater metropolitan Adelaide.

CRITERION G1 *Importance as a place highly valued by a community for reasons of symbolic, cultural or social associations.*

The dam and environs have been developed and promoted by the State as a picturesque area which is highly regarded by the community as a regional attraction. An attractive picnic area is located adjacent to the dam and visitors are able to walk across the dam crest and to observe the unusual acoustic phenomenon referred to earlier.

The dam is also actively promoted as a tourist stop for national and international tourists visiting the Barossa Valley, the nearby internationally renowned wine-growing region. The region is also famous for its European heritage and festivals, and is one of the principal tourist areas in the State. Approximately 300,000 tourists per year visit the dam all year round.

ENGINEERING HERITAGE – ASSESSMENT

Item Name:	Barossa Dam
Location:	Near Williamstown, SA
State Heritage Register:	The Barossa Dam has been included in the South Australia State Heritage Register. Register No: File No. 15088 Relevant Criteria: "(e) It demonstrates a high degree of creative, aesthetic or technical accomplishment or is an outstanding representative of particular construction techniques or design characteristics"
Designer:	South Australian Engineer in Chiefs Department and A B Moncrieff.
Builder:	Engineer in Chiefs Department.

Description:

Dam Type	Concrete Arch
Height	35m
Radius of Upstream Face	60.96m
Length along Crest	144m
Volume of Concrete	The volume of concrete in the wall is 13,743 cubic metres and is comprised of concrete and large rocks (termed "plums"). The plums were used to economise on the use of concrete and occupy 12% of the volume.
Spillway	No spillway facilities were provided as a catchdrain was built at the same time as the dam to prevent storm runoff from the local catchment entering the reservoir, and the water diverted to the reservoir via a tunnel from South Para River can be controlled by gates at the tunnel entrance.
Reservoir Volume	4,510 megalitres
Reservoir Surface Area	62 hectares

Physical Condition: The dam wall remains in excellent condition after more than 100 years of service with on crack near the Western abutment attributed to seismic activity in 1954.

Modifications: The handrailing along the dam crest has been upgraded a number of times since original construction in order to meet prevailing

safety standards. The current guard fencing was installed in 1996. It is interesting to compare the robust construction required these days against the single dangerously open (but apparently acceptable) picket and chain fence shown on photographs of the dam at the time of construction.

Aesthetic Significance: Refer National Estate information Criterion E1.

Social Significance: Refer National Estate information Criterion G1.

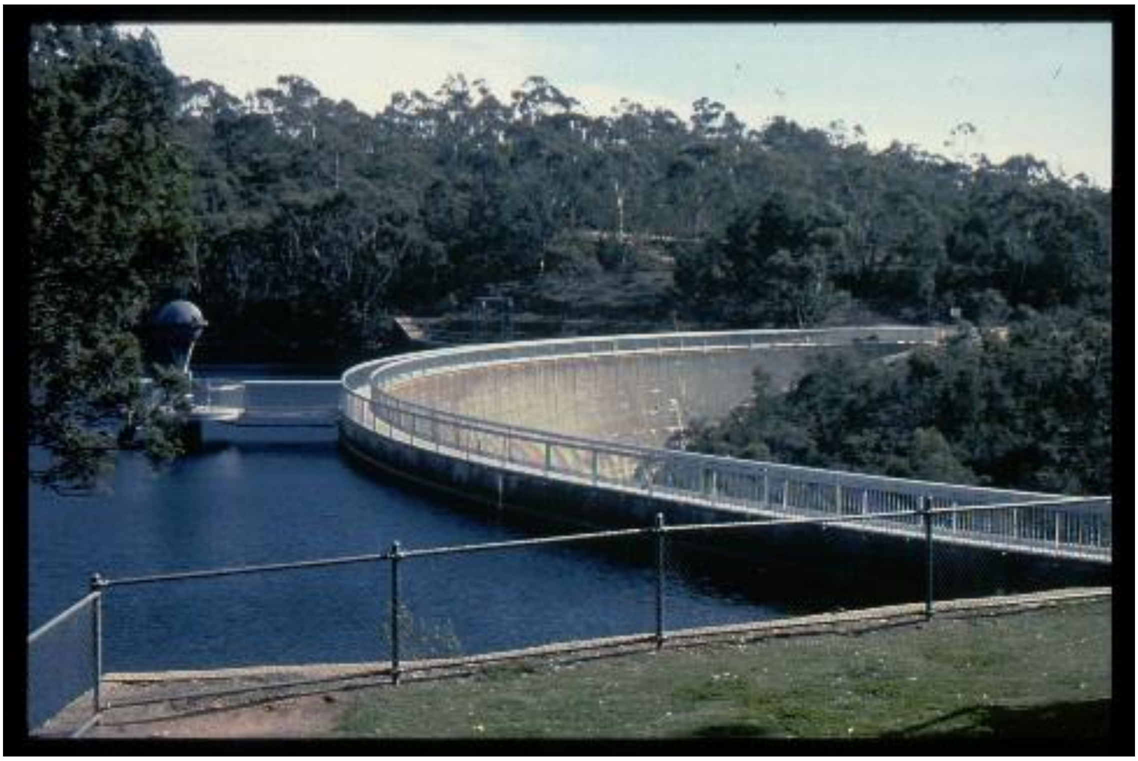
Rarity: Unique. Australia's first high concrete arch dam wall.

Integrity: Apart from the handrails the integrity of the wall is very high.

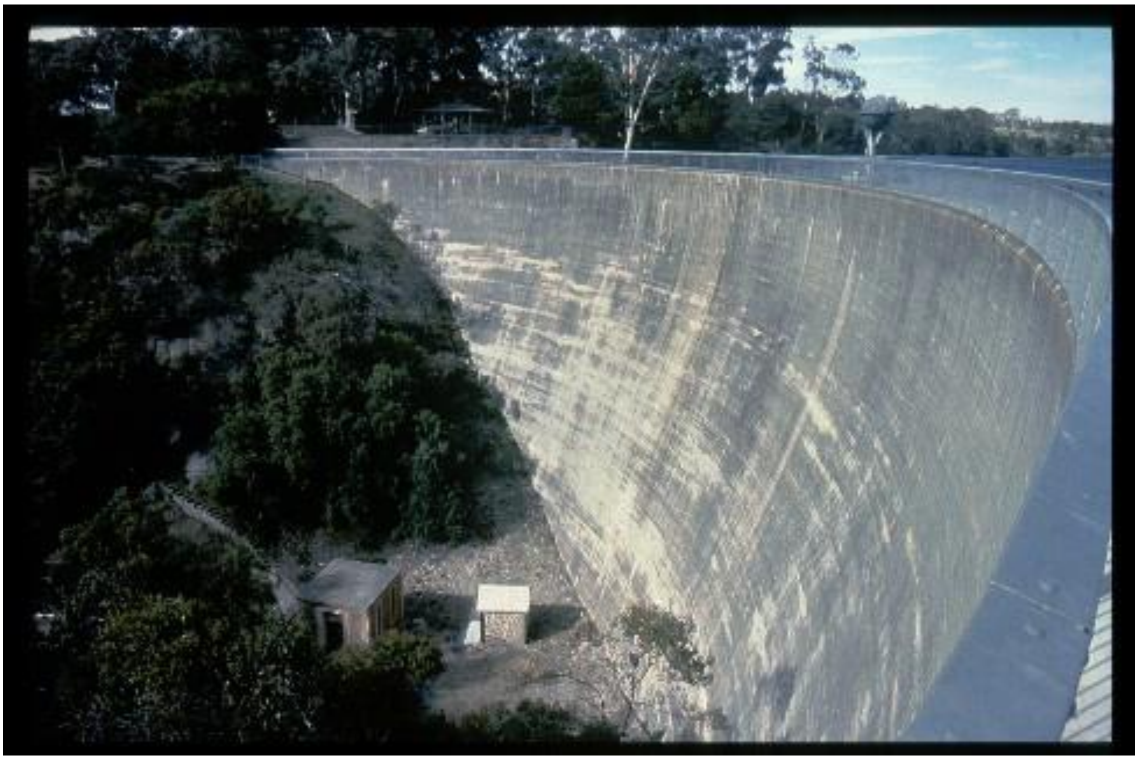
Proposed Plaque Wording

Barossa Dam Wall

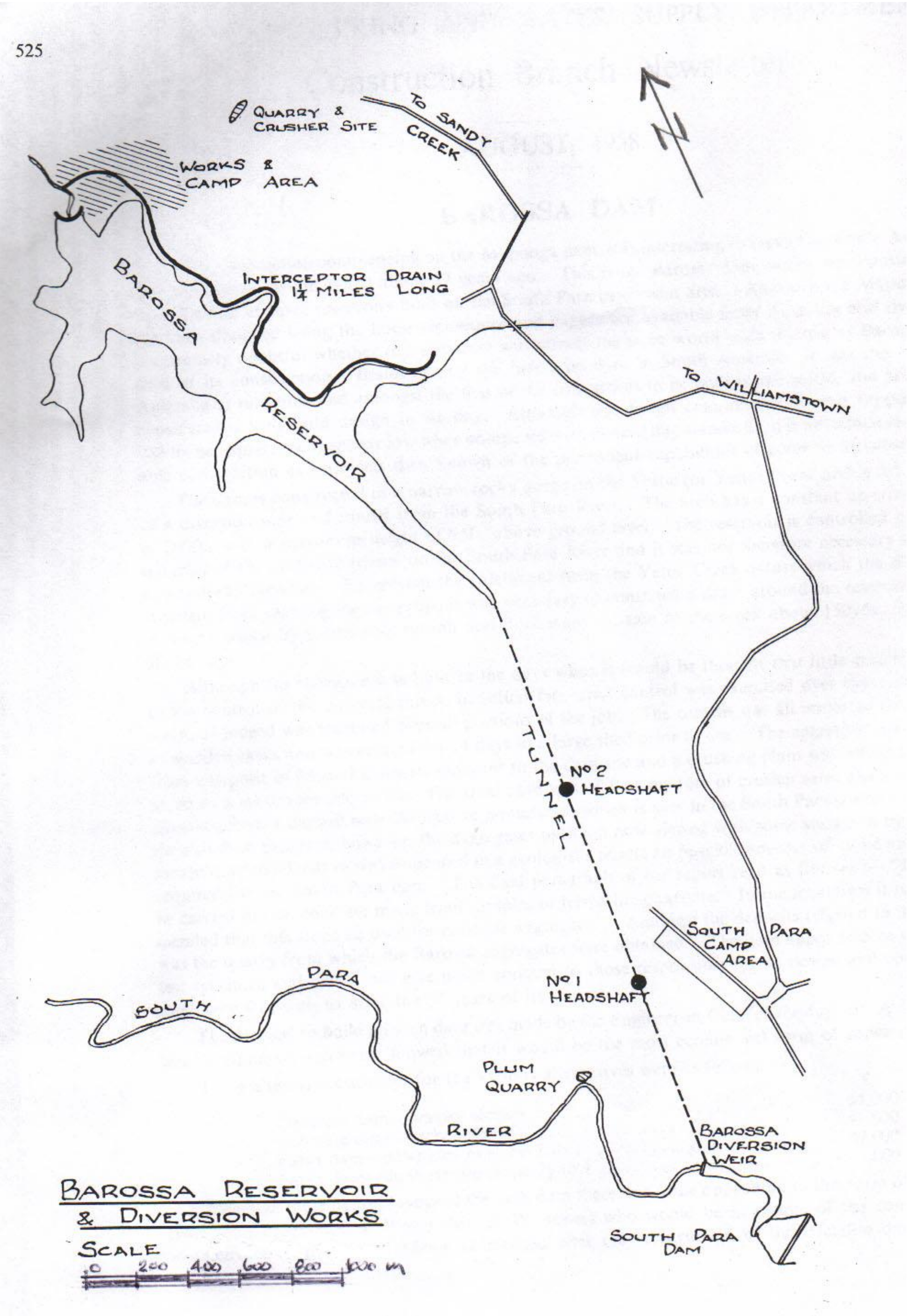
The Barossa Dam Wall is the key component in the Barossa Water Works built during the period 1899-1903 and vital to the development of the Gawler district. This wall is constructed in concrete in the form of an arch and at the time of its building it was the largest in Australia and amongst the thinnest and highest true arch dams in the world. Designed by AB Moncrieff C.M.G, MICE, the Barossa Dam extended the boundaries of dam design and construction techniques in Australia. The last concrete was placed in the dam wall on 25 September 1902.



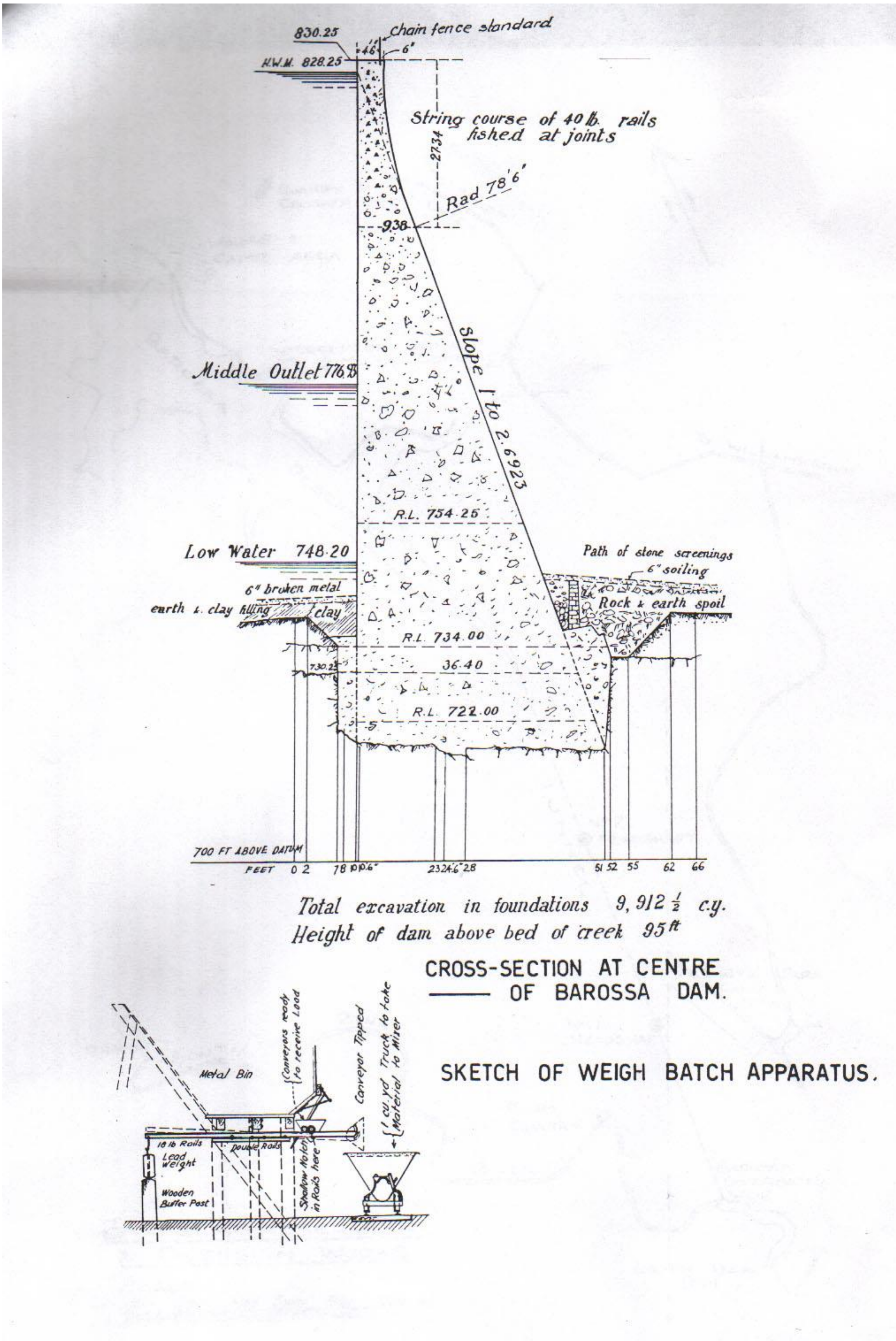
Barossa Dam Wall Crest [looking west]



Barossa Dam Wall [looking east]



Barossa Reservoir General Arrangement



Dam Wall Cross Section [from original drawing]